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No. 58

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COMPOSITE MATERIALS HAVE WIDE RANGE OF APPLICATION

Paris SCIENCES & AVENIR in French Mar 81 pp 84-90

[Article by Dominique Leglu: "Some Materials For Doing Everything"]

> [Text] Little fibers are now making large materials lightweight and strong at the same time. From rockets to prostheses, the fields of application for composite materials are multiplying. Only the automotive industry hangs back.

A helicopter pilot was recently on a mission in high mountains when the blades of his craft unfortunately hit the top of a fir tree. The pilot did not note any problems. Fifteen minutes later, at a refueling stop, he checked for damage. But everything was all right: the helicopter blades made of composite materials had again succeeded in bringing him down safely.

This anecdote, told by Mr Torres (research department, Aerospatiale [National Industrial Aerospace Company (Fr)], shows at the same time the virtues of these "new" materials and the trust which is placed in them. Today they have displaced metal blades, which aged much too fast. There is a definite preference for glass fiber reinforced blades, which are relatively resistant to corrosion, impacts, and nicks and whose service life is virtually unlimited.

Lightweight, strong, and rigid, the composites have the look of being champions in all categories. Right from the first they pulled into the front rank, beating out light alloys, steels, and plastics. Besides capturing the interest of engineers involved with advanced technologies--construction of airplanes, helicopters, satellites, etc.--the fever has even touched the automakers and manufacturers of sports equipment.

What then is a composite material? There are numerous types. After all, any mixing of two or more materials will qualify. The idea sprouted a long time ago in the mind of man: consider the old houses with their cob walls, made of mud judiciously mixed with straw, which holds up much better than mud used alone.

But the development of composites quite specifically targeted to replace traditional structural materials is very recent. And the ones presently getting the most attention are unquestionably the materials reinforced with fibers. This is why there is so much talk of glass fibers, carbon fibers, Kevlar (a very strong type of organic fiber developed by DuPont), boron, silicon carbide, etc.

Very Strong "Angel Hair"

Why fibers? To this question, Anthony Bunsell (Paris School of Mines) answers simply that the material in this form possesses extraordinary properties. Glass fibers, for example, are 500 times stronger than bulk glass. There are at least two reasons why this is so. A material in massive form never actually achieves the theoretical strength it should have considering the intrinsic strength of the chemical and physical interatomic bonds. As a matter of fact, the crystal architecture is far from being perfect: in the first place, defects manage to slip within the lattice, creating local weak spots. Then some of the sheets of atoms can slide past one another and separate easily. In the second place, a different set of flaws can often develop at the surface of a material, permitting microcracks to develop. If a substantial stress is imposed or a chemical attacks the surface, the microcrack may propagate, contributing to failure.

But with fibers the probability of surface flaws is much lower to begin with. Then, too, the molecular chains are well aligned (particularly in the case of organic fibers), due to sophisticated drawing operations during production, eliminating the cleavage planes which diminish the strength of the crystals.

These fundamental advantages are supplemented by others. It is possible to wind the fibers, align them, and make them into a fabric or a three-dimensional construction. The production grade fibers are extremely fine filaments whose diameter ranges from about seven microns for carbon fibers (one micron = one-thousandth of a millimeter) and about ten microns for glass fibers to 140 microns for a "stout" boron fiber.

Those Marvelous Carbon Fibers

A clump of carbon fibers resembles what might be taken for a tuft of very fine black hair. As another image, glass fibers have recently come to be used for making "angel hair," replacing the small cotton balls for simulating snow on Christmas trees.

Of course, with their very low diameter, using the fibers by themselves would be out of the question. But when coiled within a material (the matrix as the specialists call it), they can impart to it all their qualities of strength. Still, it is necessary to achieve a very cohesive mixture. The fibers must not "float" within the material; the physical bonds with the matrix must be strong enough so that the fibers will not pull out easily.

The production of glass fiber reinforced composites began as early as the end of World War II (see below, "In the Beginning Was the Glass Fiber"). This type of production has been the only one to really attain industrial levels. But the research laboratories today are becoming enthusiastic about other types of composites. Composites reinforced with carbon fibers or aramid fibers are already being called "noble" materials.

It has already been 15 years since someone first thought of using boron, which is very tough and very fragile at the same time. As a matter of fact, the glass fibers are not rigid enough for certain applications.

This new type of fiber is made by vapor depositing boron on a tungsten wire a few microns thick, the core of the fiber. The boron fiber, with a diameter of 140 microns, has a density very close to that of glass but possesses a modulus of elasticity* six times higher.

The boron fiber also has a very high compressive strength; it does not bend. Therefore, aluminum reinforced with boron fibers shows a specific strength nearly twice as high as that of very high-grade steel, with a density three times lower. This means that it would certainly be recommended for parts subjected to gigantic pressures, such as the undercarriages of airplanes. Australian aeronautic research laboratories have recently decided to refit the control surfaces of the Mirage III with panels made with boron fiber fabric. The sheets are rigid, resistant to loads and corrosion, and easy to shape.

Still, the quantity of boron fibers used remains low: less than 100 tons for the entire world in 1980. This stems from the fact that these fibers are delicate to make. It is necessary to create them one by one with extreme care: they cannot be made on a continuous production line like the glass fibers. This explains why they are still very high in price, on the order of 2,500 Fr/kg.

Yves Appel of SEP [European Propellant Co. (Fr)] does not hesitate to offer his personal opinion that nobody will even be hearing about boron fibers 5 years from now. It must be said that boron has not stood up well to the staggering blows it has received very rapidly from carbon fibers.

Appearing toward the end of the 1960's, these carbon fibers made a name for themselves right away as true little wonders. Having a lower density (1.9 instead of 2.6), they have a modulus (i.e., rigidity) three times, six times, or even nine times higher. All at once, there are efforts to combine them with all sorts of matrices: thermoplastic, thermoset resin, metal, carbon, etc. All these new materials to some extent are part of the fallout from space research. They are found on missiles or rockets in high-performance parts.

SEP proposes one way of classifying composite materials into five families: thermal, carbon/carbon, ceramic, structural, and laminated. The first kind (thermal) is capable of sustaining high temperatures (on the order of 2,000°C) and thus protecting the solid-propellant propulsion systems on ballistic, tactical, and space missiles. They are used for solid-propellant fuel cases and for thrust nozzles. They are fabricated from a rigid or supple matrix (thermoset resin or elastomer) reinforced with refractory fibers, often woven.

It is this type of composite material which ought to see fullest development in the coming years, particularly in aeronautics. The Boeing Company, for example, has estimated that the utilization of composite materials on the Boeing 767 would permit saving nearly a ton on the weight of the plane (about 80 tons empty). Among the various materials, those with carbon fibers in an epoxy resin matrix have been the subject of very extensive research. On the Boeing 737, there have been in-flight tests involving 111 spoilers on 28 airplanes of seven airline companies. After 1,200,000 hours of flight, the results have turned out to be very encouraging: the carbon/epoxy resists moisture and corrosion well. The materials of the second family, the carbon/carbon composites, possess particularly remarkable properties, enabling them to surpass the traditional materials in a number of areas. Not only do these composites sustain high temperatures, but they are also very resistant to tension, compression, and all other sorts of stresses. The nozzle throats of the engine of the recent M4 missile are of carbon/carbon. So is the thrust nozzle of the Mage apogee motor developed by SEP.

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* The modulus characterizes the rigidity of a material. Subjected to the same load, a material with a high modulus deforms very little, while a material with a low modulus deforms a great deal.

Sophisticated Frameworks

Though these materials attain peak performance, it must be pointed out that producing them requires very exacting work. Their fabrication begins with the construction of a framework. This can be a fabric, but can also be a block assembled from strands of carbon. It is this clump of filaments or strands--in three, four, five, or even six directions--which ensures the rigidity of the final composite.

While Aerospatiale has perfected weaving machinery representing the state of the art in this field, for the time being SEP still makes frameworks for its carbon/carbon products by hand. Truly work worthy of a lacemaker.

Once the latticework is put together, it is necessary to "fill up the holes" in the construction--the specialists speak of "densifying the framework." This can be done by the pitch process* or the dry process, sometimes both. The former approach consists of impregnating the strands with pitch under pressure. Then the whole entity is heated either at about 1,000°C to carbonize it or to about 2,500°C to graphitize it (the highest-performance composites are obtained by graphitization). The operation is repeated several times, according to the density desired.

In the dry method, carbon is vapor deposited on the framework. There again, it is necessary to repeat the cycle a number of times to obtain a material of the highest possible performance. The liquid matrix-resin method involves successive resin impregnations alternating with carbonization of the framework. At each stage of this slow and tedious fabrication (taking several weeks for the dry method, for example), the pieces are continually subjected to physicochemical testing and radiographic inspection; they are put under the scanning electron microscope or even examined with laser beams.

Although up to now rockets and missiles have been the principal users for these materials, SEP and Aerospatiale are trying to diversify their applications, notably in aviation. The Mirage 2000 will thus be equipped with disc brakes made of Sepcarb (SEP's brand of carbon/carbon). The parts used in these brakes must be particularly strong and must be capable of absorbing large amounts of heat, notably at the time of emergency braking. In performance testing of steel versus carbon/carbon, the latter material largely has the better of the comparison. Moreover, the wear of the assembly remains very low, and the weight of the brakes is reduced by half.

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* Pitch: the distillation residue from coal tar.

Obviously, the high-performance composites hold promise. Their consumption could quadruple in aeronautics over the next 5 years. The French market forecasters figure on a 28 percent annual level of growth for the carbon composites. But one question remains: will these materials succeed in venturing outside the protected domains of space and aeronautics? Will they penetrate the mass industries?

From Advanced Industries to Mass Industries

Consider the case of Japan. Holding 75 percent of the world market for carbon fibers, thanks to some groups like Toray and Toho Beslon, Japan has bet on sports articles. Carbon fibers for tennis rackets or golf clubs: look for a lively advertising war, even if to a certain extent the grand champions pass up these articles in favor of good old wood.

Will the automotive industry take the plunge? Gaston Sifre (research management, Peugeot S.A.) recently participated in a conference on that subject in Cannes, a conference sponsored by the American Society for the Advancement of Material and Process Engineering (SAMPE). His answer to the question was guarded.

The spectacular feats like the car built by Ford in 1979 using carbon fibers, with a 33 percent weight reduction, must not be allowed to hide the general situation. Millions of dollars were swallowed up in constructing one such prototype. Going to assembly line production, at the level of 1000 or 2000 vehicles per day, is another story. According to Sifre, we should not expect a revolution of composite materials, but rather a gradual evolution of their utilization.

They certainly offer all sorts of advantages: good fatigue and corrosion resistance and excellent acoustic insulation. But numerous difficulties still stand in the way: their cost, obviously; the difficulties in the fabrication processes--resins do not cure fast enough for use on a production line; a poor knowledge of their aging behavior, etc.

Also, it is necessary to specify what part of the automobile we are talking about: the body, the chassis, or the moving parts.

As concerns the body, the utilization of high-performance materials seems for the moment limited to reinforcement of fragile portions of the structures. In the engine, the ceramic-matrix composites seem very promising. Their mechanical strength is indeed high at elevated temperatures, and they are very resistant to oxidation as well as to most chemical products. The laboratories of the principal automakers have already begun their research. In the greatest secrecy, to be sure, since the present competition is fierce.

Hesitancy in France

Moreover, the introduction of these new materials requires completely rethinking the vehicle. Indeed the issue is not just simply replacing an individual metal part with a part made of composites: it is necessary to design the vehicle in terms of the new materials. This study is very costly and takes time. So much more time, to be sure, that French engineers do not seem really awake to the problem. While the Americans and British can boast two journals of specialized information, JOURNAL OF COMPOSITES and COMPOSITES, there exists no equivalent in France.

Preoccupied with these problems, Anthony Bunsell became the active organizer of the very newly formed association for composite materials (AMAC).* At his prompting, the third international conference on composite materials was held in Paris last August. It has been noted that out of 130 conferences, only 18 emanated from France, versus 28 for Great Britain and 38 for the United States.

The web of interests thus is duly being woven, but the industrial development remains slow. Perhaps it will be necessary to wait for something to make a real impact on the public. This could happen thanks to special uses, such as in surgery. As it turns out, the carbon/carbon composites seem destined for an interesting future in the field of surgical prostheses, notably knee prostheses. Of course cardiac valves have already been made of polycrystalline graphite, but the composites bring an additional advantage: their mechanical properties, particularly their fatigue resistance.** Also, carbon possesses an undeniable advantage over most materials: its biocompatibility, not to mention its porosity which favors controlled growth of tissues. Numerous experiments have already been done on sheep and dogs.

Initially employed in aerial, terrestrial, maritime, and submarine space conquest, the composites could thus soon touch us much more closely: finding a place even in the interior of our own bodies.

Carbon for Violins

Will the masters of Cremona turn over in their graves? Pine and maple, pear, and sycamore wood all but eliminated? Two daring Canadians have within the last 2 years used carbon fiber reinforced epoxy resin to construct violins. An odd meeting between Leonard John, presently head of composite material development at de Havilland Aircraft, and Robert Innes, a well-known violinmaker.

In fact, only the belly, ribs, and bridge of the instrument have been constructed in composite materials. The neck, scroll, finger board, tailpiece, and tail-pin remain faithful to the traditional woods.

After a great many discussions, the two acolytes settled on using carbon fiber. Glass was judged too supple and Kevlar was considered bad for the sound. Furthermore, an acoustic analysis was done on a sample violin in order to determine with precision the vibratory characteristics the instrument should have.

Placed in the hands of a violinist of international renown and three concert violinists, these new-style instruments gave complete satisfaction.

On his own, John is busily working to construct a carbon violin on the model of a Stradivarius.

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* Registered office: Centre des materiaux, 60, bd Saint-Michel, Paris.

** See SCIENCES & AVENIR, No. 406, December 1980.

In the Beginning Was the Glass Fiber

Cheap and rather easy to construct, the materials reinforced with glass fibers account for 90 percent of the market for composites.* Implanted for a long time now in automobiles--where we remember the celebrated roofs of glass fiber reinforced polyester on the Citroen DS introduced in 1955--they are being developed a little further all the time. Thus, bumpers of glass/polyester have replaced the traditional metal bumpers on the Renault 5 and the Renault 14.

Their applications in the building trades have become too numerous to count. The new fabrication processes allow construction of profiles in all shapes, with high mechanical strength obtained by using glass in amounts ranging from 50 to 75 percent by weight. Excellent thermal and electrical insulators, these profiles are also resistant to weather, chemicals, corrosion, etc. They are being given serious consideration for use in the chemical industry for pipes and large tanks 100 m^3 in capacity, and even 1,000 m^3; that is already being done in the United States and Italy.

The producers are not skimping on research, particularly in the development of matrices. The West German company BASF, a little more than a year ago, introduced polyester resins which polymerize when irradiated with ultraviolet light. Simple neon lamps are therefore replacing the traditional mercury vapor lamps. For an even faster polymerization, the use of infrared equipment, in addition to the neon lamps, is envisioned.

But the glass fiber composites have really earned their stripes in particularly critical applications, such as helicopter blades. The safety of the aircraft depends on the strength of the blades. But these blades are subjected to all sorts of stresses as they turn: traction, flexure, torsion, etc.

Since 1968, with the first Gazelle helicopter, the French helicopters made by Aerospatiale have been equipped with glass fiber/epoxy blades. A judicious orientation of the fibers enables them to accommodate the various stresses.

The leading-edge spar of the blade is fabricated from impregnated tape in which the glass fibers are aligned longitudinally. The outer skin of the blade is made with woven mats impregnated by hand with epoxy resin. An orientation of the fibers at a 45° angle to the previously mentioned fibers provides the necessary torsional stiffness.

More than 4,000 Gazelle helicopters now fly with these blades. Another victory for the composites: the Starflex rotor hub installed on the light Ecureuil and Dauphin helicopters. A vital piece of equipment, its framework consists of a star of laminated material obtained by laying up glass mats impregnated with thermoset resin.

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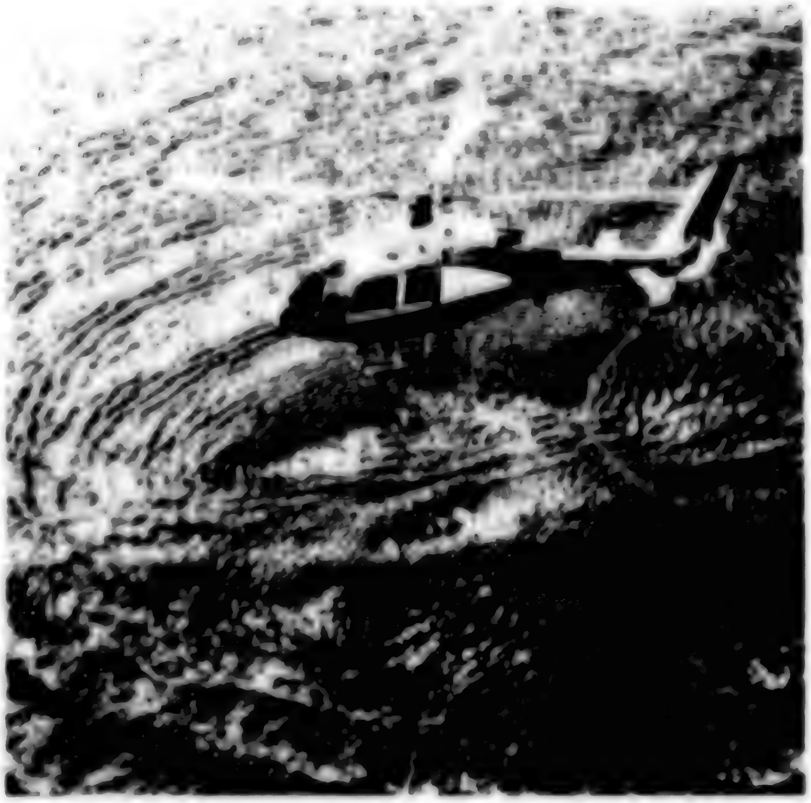
* The French market for glass fiber reached 45,000 tons in 1980, a fourth of the European market, and predictions are on the order of 80,000 tons for the 1990 horizon.

This flywheel was fabricated by filament winding of carbon fibers. Their tensile strength is such that a wheel of this type can spin at speeds much higher than those possible for a metal flywheel, thus permitting much more energy to be stored.

Launched in 1978, the British ship HMS Brecon, 60 meters long and 625 tons, is the largest boat in the world built with a glass fiber composite.

All the light helicopters made by Aerospatiale, such as this Dauphin for example, are now being equipped with blades made from glass fiber/resin composites. Much more resistant to fatigue than the old metal blades, they also have very high impact strength, being capable of severing a 20 x 20 cm wood beam without being damaged.



9828
CSO: 3102/219

AEG TO HELP BUILD PHOTOVOLTAIC DEMONSTRATION PLANT

Hamburg DER SPIEGEL in German 30 Mar 81 pp 98, 100

> [Text] The AEG electrical company wants to demonstrate that electrical demand can be met with solar generators.

The company has had to put up with enough criticism, so AEG manager Eckehard Schmidt at least wanted to praise its achievement: "No one besides ourselves," said Schmidt about his own area of expertise (new technologies, space travel), "in the Western World can do what we are doing."

In the confined workshops in Wedel in Schleswig-Holstein, Schmidt and a few dozen engineers and experts are experimenting with a technology that will repair the German electrical company's reputation: AEG is planning to build large-scale electrical plants that need nothing other than daylight to generate electricity.

The technology (photovoltaic) is known--solar generators transform light immediately into current. Similar power generators have long been a familiar sight in space travel even to laymen: The paddle-like components on satellites and space stations are nothing but solar generators.

The AEG team in Wedel also learned its trade in the space travel business; it supplies solar cells for German, European and American space programs. Besides AEG, only the U.S. Hughes company in the Western industrial nations can build solar generators for satellites.

Solar cells, in which electrical energy is generated, are pure silicon slices which have been contaminated with tiny, positively or negatively charged metal particles. If light, best of all sunlight, falls on the slice, a flow of current is generated between the metal traces. The current is collected in printed-on silver wires, concentrated and transmitted to the consumer.

Solar generators, at least in theory, can provide electrical power in a strong light, at any level and amount desired. Reality is proving a little more difficult: 1 m^2 of solar cells produces at best (bright sunshine) 1 kW of electricity. Under cloudy skies the output drops to 100 watts per square meter.

So for major industrial electrical production solar cells are out of the question at the moment--they require too much space. But for decentralized small consumers they are ideal. Even under cloudy skies, 30 m^2 on the roof of a house would provide as much electricity as a family normally uses. It has already been proved that solar devices function reliably on earth without maintenance. Buoys are anchored in the Elbe, for whose flashing lights solar cells built by AEG provide the power. In Indonesia entire rice fields are irrigated with the aid of solar power, and the mountain climber Reinhold Messner in the Himalayas derived the current to operate the radio link with his base camp from an AEG generator.

So it is only price that is preventing light-powered generators from finding widespread use The manufacture of solar cells from silicon has been so expensive until now that solar electricity for private use has simply been uneconomical. The devices from Wedel only made sense in space and on earth in remote regions where electricity would have been unobtainable otherwise. "Five years ago," according to Schmidt, "1 kW of electricity cost us DM 500,000." Since then the price has dropped to DM 20,000, and in 5 years Schmidt wants to market 1 kW for DM 5,000.

AEG managers want to achieve that with new production methods. The most important steps have already been taken.

For example, at AEG in Wedel the conductor connections for the individual silicon slices, which are arranged on a generator board, are now soldered completely automatically. AEG engineers developed the automatic soldering machines; other manufacturers are still soldering the connections manually. With state assistance AEG has also developed a new production process which is designed to lower the cost of the solar cells themselves considerably. Until now the silicon for the generator boards was diverted from the production for silicon chips. But the customary high standards for solar chips is not necessary for solar cells.

AEG technicians have progressed to the point that they want to test their solar system on a large-scale project. Financed by EEC and state funds, they will build a solar plant on the North Sea island of Pellworm with an output of 300 kW--the largest of its kind in the world to date. The solar power plant is designed to supply the local spa, several surrounding businesses and a number of private houses with electricity.

Since there is more electricity available in sunshine than the inhabitants of Pellworm will need, the island is to remain connected to the grid of Schleswag, the electricity supplier.

The pilot project will cost about DM 12 million, according to AEG estimates. Once the system has been tested, according to Schmidt's prophecies, similar projects in the future would only cost about DM 2 million.

The solar power plant on Pellworm will supply electricity worth DM 150,000. If future, more economical plants can be amortized in 15 years, according to Schmidt's calculations, they will become "interesting for the private owner."

Experts abroad, who are working intensively on solar technology, confirm that Schmidt's prediction is probably correct. The Americans expect that photovoltaic technology will become a billion dollar industry by the year 2000.

In Germany one hurdle will still have to be cleared: the electricity producers will have to be convinced that they should buy excess electricity from solar plants from their own customers.

The experts assume that, in principle, every private household can become a net producer of electricity: With solar generators (for electricity), collectors (for hot water) on the roof and a thermal pump in the basement, it would be feasible even in the northern regions of the FRG.

If the solar technicians had their way, nuclear energy and oil would be superfluous today for the country's electricity supply: "Electricity consumption," AEG's Schmidt claims, "could be met with solar generators which take up only 1 percent of the surface of the FRG."

9581
CSO: 3102/218

LONG-TERM HEAT STORAGE SYSTEM FOR SOLAR ENERGY TESTED

Oslo AFTENPOSTEN in Norwegian 19 Mar 81 p 32

[Article by Georg Parmann]

> [Text] If solar energy really is to make a breakthrough as an energy source for home heating in the Nordic countries, an effective storage system must be developed. Many attempts have been made and one of the most promising so far was recently presented in Stockholm. It is a chemical heat storage system, a heat battery which also functions as a heat pump. It has now been tested in a house on the outskirts of Stockholm and the company that produced it estimates that it will be ready for marketing during the next few years.

Even when the first attempts were being made to use solar energy in Scandinavia after the oil crisis of 1973, workers began to find methods of storing heat energy from the summer to the winter. This was accomplished in the so-called zero energy house at Denmark's Technical University in Lyngby, but the cost of the system prevented it from even approaching what could be considered economical.

Most of the solar houses later built have had so-called short-term storage. This means smaller storage devices designed to even out temperature differences between day and night plus storage for a short period of time, from several days with good weather to several days of overcast weather. Many experiments are being carried out, however, to discover a method of storing heat energy over a longer period of time at an acceptable price. To achieve this, it will probably be necessary to resort to chemical storage, but so far few have been able to demonstrate that such storage is feasible other than on the laboratory scale.

Promising Chemical System

In 1976, however, a research group at the Royal Technical University in Stockholm began to develop an energy storage system that now seems promising. It is now being tested at a private home in Jakobsberg on the outskirts of Stockholm. There a solar collector with a 40 square meter surface has been installed. Using these solar collectors and the chemical storage, which has a capacity of 7,000 kWh, the heating and hot water needs of the entire house can be met with solar energy. It is estimated that the house normally would need an energy supply of 20,000 kWh for these purposes.

The system itself consists of a closed container with a salt, sodium sulfite, and a container with water and a vacuum pump. The two containers are connected to each other by an air-free pipe system. The chemical reaction used is based on the fact that when sodium sulfite is added to water, heat is released. On the other hand, when heat is added the salt can be removed from the water.

The system is charged by allowing warm water from a solar collector or other energy source that produces warm water to pass through a heat exchanger in the energy storage unit (salt container). When the temperature reaches a certain level, water vapor is liberated and it condenses in the water tank. The heat of condensation is removed from the water tank by way of a heat exchanger. When the salt is completely dry in the energy storage unit, as it is constructed at the house in Jakobsberg, it contains a potential energy of 7,000 kWh.

This energy can be liberated by the opposite process. When heat is lost from the energy storage unit to radiators, etc, in the house the temperature in the storage unit drops. This leads to a difference in pressure between the energy storage unit and the water tank, which causes the water to evaporate. The water vapor proceeds to the storage unit where it combines with the salt and liberates heat.

Simple As Oil Burner?

For the system to function, some technical subtleties are required, but this heat source can be controlled about as easily as an oil-fired system. The chemical energy storage system was developed primarily to make better use of solar energy, but other energy sources can also be used.

Professor Ernst-Ake Brunberg, who led the project, says that the chemical heat batteries can also be "charged" with energy forms other than solar collectors. For example, where excess heat from industrial processes, etc, is present, it can be used to charge the system. Instead of having pipes for district heating, it could be possible to transport the "heat batteries" to the energy source for charging and then return them for use.

Brunberg is reluctant to give any precise figures on the cost of the storage project. However, he firmly believes that the system can be marketed within a few years and that means that it must be produced at a cost that would make it competitive with other forms of energy. It is the construction and installation costs that will be predominant. Operational costs will be minimal once the system has been installed, Brunberg said.

9336
CSO: 3102/223

ELKEM, ESSO JOIN FORCES FOR SOLAR CELL DEVELOPMENT

Oslo AFTENPOSTEN in Norwegian 25 Feb 81 p 28

> [Text] Elkem A/S and Esso will join forces in a research program to develop a more efficient method of producing practically pure silicon for use in solar cells. The project will last 2-1/2 years and the companies will invest a total of 35 million kroner in research and development. If the project is successful, the companies will be prepared to compete in what has been called a very interesting and expanding market. It has been estimated that around 1990 the world market for solar cells will be between 5 and 10 billion kroner per year.

Elkem A/S already has a production capacity of 60,000 tons of silicon per year and most of this production is used for aluminum and silicones. For this latter purpose, by the way, the company is the largest producer of silicon in Europe. However, the company now wishes to enter more nontraditional areas for the use of this substance and a year ago Elkem and Esso established contact. Negotiations began and the result is an agreement for cooperation, which was described at a press conference in Oslo on Tuesday.

Elkem's partner is Solar Electric Venture, Exxon Enterprises, Inc. Seven years ago Esso began to market solar cell products. Today they are sold in 40 countries and the company has a sizeable share of the market.

It is primarily in isolated areas where it has so far been expensive to supply electricity and where diesel generators have previously been used that the solar cells may be competitive as electricity sources. The advantages of solar cells are that they require no fuel, contain no moving parts and therefore require little maintenance, and they cause no pollution or noise during operation. The greatest disadvantage is the high initial cost, which today is around 50 to 75 kroner per kw-hour. This will improve, but for the time being solar energy can compete with conventional methods only in certain areas.

Thus, the idea is to lower the price and this is the purpose of the agreement which has now been signed. "Elkem and Esso together have so much knowledge in this area that the foundation should be present for undertaking such an interesting task and for the profitable production of silicon here in Norway," director Rolf Nordheim of Elkem A/S said at the press conference. This silicon would be more than 99 percent pure. If the project proceeded to the production stage, Elkem will build a new melting furnace for this production, presumably with a capacity of around 1,000 tons per year. The Norwegian market for solar cells will initially concentrate on vacation homes and communications installations on mountain tops.

9336
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INDUSTRIAL TECHNOLOGY

GOVERNMENT AIDS AUTOMATION OF INDUSTRIAL PROCESSES

Paris LE NOUVEL ECONOMISTE in French 30 March 81 p 59

[Article by Alain Jemain: "One Billion for Robots"]

[Text] "Let's go, this is the time." Mr Pierre Gadonneix, Director of the metallurgical, mechanical, and electrical sections of the Ministry of Industry could not help saying last Tuesday, in order to incite French businessmen to get in step with robotics. He proclaimed that neither fear of the unknown or of financial difficulties should slow the indispensible automation of industrial processes.

It is true that after 10 years of hesitation and half-measures, the government seems to have finally decided to use its full array of weapons. Earlier this month the Council of Ministers expanded the list of areas, equipments, and allowances which benefit from the Meca procedure: financial assistance amounting to 4 to 20 percent of the investment, technical advice and assistance from the Agency for the Development of Automatized Production headed by Messrs Michel Barba and Christian Sauvaire, professional education and re-training, etc. At the same time, the government decided to double the size of companies eligible for this assistance (up to 1000 employees).

Today, the government is detailing the conditions of eligibility to the "billion francs in loans" promised by the President last December. The National Credit Bank, the Regional Development Agencies, the financial office for equipment of the PME, [small and medium-sized businesses], and the interdepartmental services of the Ministry of Industry have just received a directive that establishes the conditions of eligibility for these new government loans.

--Beneficiary: any company in any field and of any size, which commits itself to implementing--while meeting satisfactory profitability objectives--an investment program allowing at the same time "to automate a non-continuous production process, utilize advanced equipment, and improve productivity." Minimum investment: 1.5 million francs.

--The kinds of equipment concerned are the same--since last 11 March--as those covered by the Meca process: numerical-control machine-tools, electronic control machinery, automatic handling equipment, special machinery, industrial data processing equipment, computer-assisted design systems, programming, and engineering.

--Assistance may reach up to 70 percent of the total amount before taxes for programs newly-committed between 1 January 1980, and 31 December 1982. Two methods are available: long term loans with a maximum duration of 12 years (with a 3-year depreciation extension) and with an interest rate two points lower than the regular National Credit Bank loans; or shorter term bank loans with a maximum duration of 7 years and at a 1 percent discounted rate. Their availability will be linked to the increase in export capabilities, savings in raw materials, and increased use of coal that can be achieved.

Mr Gadonneix stated that "The Japanese are demonstrating to us that through the extensive use of automation, it is possible not only to lower costs, but to improve the characteristics of the products. If we do not take the step right now, and there is still time, we will no longer be able to export, to protect our internal marketplace, or to fight successfully for full employment."

6445
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EUROPEAN AUTO INDUSTRY NOT 'UNDER-ROBOTIZED'

Paris L'USINE NOUVELLE in French 2 April 81 pp 56-57

[Article by Georges Le Gall: "Renault: An 8000-Robot Pool"]

[Text] Somewhat irritated by the widespread idea that Japanese automobile manufacturers are far ahead of their competitors in the area of robotics, Renault management has just completed a survey of the number of robots in use in its plants.

Using the Japanese classification (where small handling machinery is counted as well as high technology equipment), Renault owned, as of 1 March, 1981, a pool of about 8000 robots for the whole group. In the automobile division alone, an accurate survey counted 4600 robots (500 remote handlers, 2200 fixed-sequence handlers, 1700 programmable-sequence handlers, and 200 high technology robots).

Renault's represents one-sixth of Europe's automobile production. Since it is probable that other European manufacturers are similarly equipped, the automobile divisions of the European manufacturers therefore own about 28,000 robots (4600 x 6).

Where do the Japanese stand by comparison? At the end of 1980, their total robot-pool is evaluated at 77,000 units, about 38 percent of which is in the automobile industry, or 29,000 units. Last year, automobile production was about the same in Western Europe (12 million vehicles) as in Japan (11 million vehicles). European manufacturers are therefore not "under-robotized" in comparison with their Japanese competitors. The make-up of the robot pools is about the same: in Japan as in Europe, more than 80 percent of the robots are fixed or variable-sequence handlers.

Without being paradoxical, it is possible to say that, considering all industrial areas, Japan is not "over-robotized." The proof is that in 1980, the Japanese government instituted three measures to increase the use of these types of equipment: creation of a robot rental agency; availability of low-interest loans for companies upgrading their equipment; accelerated depreciation of high-technology robots. The director of JIRA (Japan Industrial Robot Association), Kanji Ynemoto, has just revealed that his organization has asked the government to increase its assistance to robotics research, because they believe that the United States and West Germany provide higher subsidies.

Although it is not behind in robotization, the productivity level of the European automobile industry is evaluated at only about two-thirds that of its Japanese competitor. This is due to economic reasons (less standardized equipment, less subcontracting, lower utilization time of machinery, etc.) as well as social reasons (higher absenteeism, less qualified manpower, higher burden rates, etc.). A modern production tool is a necessary condition of competitiveness, but it is not sufficient!

6445
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TRANSPORTATION

NEW GENERATION OF COMMUTER AIRLINERS ON THE WAY

Background Information

Paris AVIATION MAGAZINE INTERNATIONAL in French 15-31 Mar 81 pp 32-33

[Article by Pierre Sparaco: "The New Commuter Airlines: 2,000 Airplanes in 15 Years?"]

> [Text] The giants, which are becoming fewer and fewer, are fighting relentlessly over the market for jumbo airliners. At the same time as several prominent names in the industry have had to abandon the battle against Boeing and Airbus Industrie, the smaller manufacturers and the outsiders, new manufacturers looking to the expansion of civil aviation, today find themselves face to face in an equally spectacular confrontation, that of the so-called third level aviation.

Decisions made during the last few months confirm a trend taking two closely related and complementary directions: on the one hand, rejuvenation of already well-known series and, on the other, creation of a completely new generation of commuter airliners. Speaking proportionately, this slot requires investments which are larger. And the sales prospects, although frequently bearing the imprint of some optimism, are enticing.

In this connection the various estimates agree with each other relatively precisely: about 2,000 airplanes over the next 15 years. What is more, 1,500 in 10 years, taking into account military outlets and markets for "executive" versions of airplanes designed originally for operation by regional scheduled airlines. No doubt half of this potential market, indeed even more, will involve the 30 to 40 seat category, for which the figure of 600 to 800 is cited.

The American Inspiration

The geographical distribution of this potential market is not always clear. Certainly, North America is to a large extent dominant: to the extent of impelling the extensive industrial maneuvers of various aspirants in seeking an American partner. But the other parts of the world are assuming increasing importance, including the developing countries.

Nevertheless commercial application is difficult. It is not only a matter of estimating the growth of regional and similar traffic but also, and above all, of considering the effects of a regulatory framework undergoing evolution. For example, what would happen if the ideas evoked by the EEC [European Economic Community] in connection with the closer intra-European regional links were to gain ground? And what if the monopolies of national companies were to benefit from a certain flexibility?

The fact remains that the American example is ever present, because some 300 airlines in the commuter category there transport from 12 to 14 million passengers each year. And that figure is a gross understatement because the statistics are incomplete, the smallest airlines being reluctant to respond to lengthy questionnaires for lack of sufficiently staffed administrations.

Mrs Gloria Schaffer, member of the Civil Aeronautics Board (CAB), recently emphasized the consequences of deregulation of American air transport for third level operations: the prospects for its expansion are greatly enhanced. This is so because access to new markets is facilitated and, at the same time, because of the ease with which the large airlines can now abandon operations at small stops of only marginal interest. Last, the more out of the way communities now more than ever need an umbilical cord connecting them to the systems of the second and first level airlines. From this viewpoint subsidies come into play within the scope of the Essential Air Service Program.

The major portion (three-fifths) of the U.S. commuter traffic is related to flights connecting with the local carriers and the trunk lines. The president of United Airlines, Richard Ferris, by the way, has just reiterated, in this vein, the extent to which cooperation with the third level is important. The largest airlines need the traffic which the smallest operators bring to them. This is another reason, even if said in passing, for the third level airplane to evolve toward a degree of comfort more than merely adequate, which in turn influences their design (notably with the widespread use of pressurization).

The historical importance of the American market explains the naturally strong position of several North American manufacturers. And for a long time the regulatory standards of the CAB (from the standpoint of capacity) and of the Federal Aviation Administration (from the technical standpoint) served as the essential points of reference. The notorious limit of 12,500 lbs (5,700 kg) which formerly could not be exceeded still persists in everyone's memory.

Today the study bureaus have full freedom: First of all U.S. commuters have benefited from a capacity ceiling of 30 additional seats, up to 60. And even at this limit exceptions for exceeding it are possible. On the other hand, the new aircraft will have to conform to FAR 25, stricter than the former standards and which will undoubtedly result in more expensive aircraft.

A Confusion of Choices

As we said, a new generation is in the process of taking shape: from 30 to 50 seats, 3 or 4 abreast, and free height within the pressurized cabin generally between 1.80 and 2 meters; units whose maximum take-off weight is between 7.5

and 14 tons, twin turboprops without exception, built by General Electric and Pratt and Whitney, each with horsepower between 1,300 and 1,800.

At the top of the line one finds two tried and true stalwarts of old design, the Fokker F-27 and the British Aerospace HS-748, designed around the indefatigable Rolls-Royce "Dart." Like the "Gulfstream" I, which is no longer in production but is marketed up to the present by retrofitting second hand airframes. We may add the special case of the British Aerospace 146, which will fly this year, four jet engines, 70 to 90 seats, which is advertised for regional operations but which, however, seems more related to the second level.

It is on the question of range that opinions diverge: the figures vary by a factor of three. And when a manufacturer promotes a distance of 1,000 to 1,500 km under full load, it is obviously for the purpose of enabling users to cover 3 or 4 successive segments, without refueling and because of this, with stopover time reduced to a few minutes. The cost under present economic conditions lies between $3 and $5 million, with the possibility for first deliveries starting in 1983.

Beyond the sketchy impression of the new generation commuter airplane it is appropriate to consider the bottom of the line with about 15 to 20 seats, and whose unit price varies from $1.5 to $2.5 million. These involve already known aircraft, in some cases produced for many years, such as the Swearingen "Metro" and the Canadian "Twin Otter," of revised design like the British "Jetstream" and Beech 1900, and models of more recent design (Embraer "Bandeirante") and even completely new aircraft (Dornier Do-228).

The second hand airplane is the most dangerous competitor with which all the aspirants are confronted. From the Beech 99 to the Fokker F-27, down through the years numerous aircraft are available from expansion, abandonment, and replacement of fleets. An element all the more important, which dominates the market, is that of financing.

There are many operators of third level airlines who, fortunately, are well aware of the limits of their capabilities. These are frequently limited because of the marginal nature of their operations, generally modest in scope, with their own funds limited. Thus it can be stated with little risk of being mistaken that the third level is well aware of its technical and operational desires but seldom has available resources of its own to satisfy them.

It may be concluded that for this reason the numerous manufacturers present in the marketplace run the risk, despite their proposals' attractiveness, of a certain number of disappointments. There are many receiving the call; perhaps there will be fewer chosen. Unless some innovative formulas are developed, for example, methods of leasing which relieve small airlines from the heavy burdens of financial investments and capital assets which are not within their reach.

Some experts, at the same time, state that in the course of time consolidations may take place. Even the CAB in the United States does not believe that. The independence and specialization of simple and light equipment appropriate for modest scope and small fleets, in spite of one or another exception, constitute the active forces and strongest trump cards of third level air transport.

The Brazilian manufacturer, Embraer, has signaled the opening of the market for 30 to 40-seat commuter airliners by starting production of the EMB-120 "Brazilia," a full size mock-up of which is shown here. Today 10 manufacturers are more or less interested in a fantastic market within which there remain to be found methods of financing. (Embraer literature)

Competing Companies, Aircraft

Paris AVIATION MAGAZINE INTERNATIONAL in French 15-31 Mar 81 pp 34-39

[Article: "They All Want Their Share"]

> [Text] As Pierre Sparaco has pointed out in the preceding article there is a plethora of commuter airplanes on the market. On the following pages we present a sketch of the throng of companies which intend to take their share. We have adopted a sequence based upon the order in which they became known and the dates of availability on the market. The list is not exhaustive: missing, among others, are Dornier, which should have its 228 (of which we shall have more to say shortly) flying before the Le Bourget Salon, and Beechcraft, whose model 1900, it seems, is still in doubt, as well as a large number of well-known airplanes such as the "Arava," "Islander," "Trislander," "Nomad," etc, which are not directly participating in the competition opened by expansion of commuter airlines' activities.

Fokker: The Extraordinary F-27

Designed more than a quarter of a century ago, that is, at a time when the term "commuter aircraft" had not yet received its present aeronautical acceptance, the Dutch twin turboprop F-27 has had a career literally out of the ordinary: more than 720 units in various successive versions for uses of all kinds have been sold. But the "Friendship" has asserted itself as a top of the line airplane for regional applications: in fact, its capacity is between 48 and 56 seats depending upon the arrangement chosen by the operator.

A remarkable fact: down through the years and market evolution every cutback in the production rate has more or less rapidly been followed by a net increase. Such is the case at present: a scant 20 units are scheduled for this year but the rate will increase to 2 per month in 1982 and perhaps even to a total of 30 units later on. This, in particular, is because of renewed interest found especially among American third level airlines.

Fokker has no hesitation in stating that in large measure the F-27 deserves to be considered as the true successor to the DC-3 as the twin engine aircraft of medium tonnage with undeniable versatility. It benefits from a basic design which resists the ravages of time very well; it is well regarded by passengers (especially because of the very pleasant visibility which results from its high wings); and from a technical and operational standpoint it combines the reliability of a simple formula with that of the Rolls-Royce "Dart."

It is all the more amazing that Fokker is no longer contemplating fitting that airframe with new motors, preferring to consider, at least 10 years into the future, an entirely new airplane (provisionally designated the F-XX) for which only discreet preliminary studies have been envisioned up to the present.

In many Third World countries the arrival of the Fokker 27 is the symbol of communication with the rest of civilization. This airplane has contributed to reducing the isolation of many regions of developed countries and to erasing boundary lines. After more than 25 years it remains young...and is still in production.

Earlier, intermediate concepts had nevertheless been entertained: the P.301 project first of all (same airframe and four Pratt and Whitney PT6A-50A), and next the P.305 powered by two by-pass turbojets of unspecified type. A more careful examination of these proposals rapidly showed that in commuter flight segments the overall fuel consumption would be higher for a speed gain of little use. That, in an economic context quite dominated by the cost of petroleum, constituted a working hypothesis to be discarded with no further consideration.

Everything leads to the belief that the F-27, which has already broken all the industry's longevity records (the Handley-Page "Dart Herald" has been forgotten; the B.Ae-748 which came later did not experience comparable success) will benefit from an exceptionally long life. All the more so as the Fokker marketing branches are complete masters of all the special features of a demanding and highly fragmented market and can, in addition, exploit the effectiveness of an after-sale service above any suspicion. It is a matter, certainly, of the value of experience.

Paradoxically, in numerous cases the F-27 (and its American version, the Fairchild-Hiller FH-227, of which production stopped perhaps a little prematurely) is competing with itself: the rule of numbers suffices to explain that many second hand airplanes are continually available throughout the world. Fortunately for Fokker, the worldwide growth in regional aviation is great enough to keep this slot at its full value. And this despite the systematic offensive of newcomers whose projects sometimes tend toward 40 seats.

In spite of appearances the F-27 has evolved considerably through the years and the present Mk.500 and 600, moreover, are offered in numerous versions, including hybrid and all-cargo. The equipment has also been modernized (for example, there is a category 2 option), the empty weight of the airframe has been reduced, and soundproofing considerably improved. This year again relatively large investments are planned (the manufacturer is talking about several million florins, without other details) to preserve the vitality of the F-27.

British Aerospace: Coasting Along

The prototype of the B.Ae-748, that tried and true stalwart of the British industry, made its first flight in June 1960. Designed around the indefatigable Rolls-Royce "Dart," this airplane has had repeated successes and about 350 units have been sold to no fewer than 74 users in 48 countries. Concluding that the petroleum crisis and the expanded operations of the third level are giving renewed economic viability to an airplane of this type, capable of transporting 40 to 58 passengers and taking off from rudimentary airports, British Aerospace is now striving to push the 2B version ("Dart" 536-2) having, in particular, a wingspan lengthened by 1.20 meters.

An interior within a deceptively wide fuselage, greatly reduced noise level, and modernized instrumentation effectively inspire the hope that there will be additional orders, all the more easily negotiated because production, although at a very slow rate, has never stopped. The first 2B models were delivered in the beginning of 1980 (to Air Madagascar). A contract signed by the German domestic airline, DLT, confirms that the B.Ae-748 is actually still present among the large capacity commuter airliners.

The "Jetstream" 31: Designed 15 years ago by the now defunct Handley-Page firm, and taken over by Scottish Aviation, this twin turboprop resumes a place in the British Aerospace line in a modernized version equipped with two 900 horsepower Garrett TPE 331-10 engines. An order from the Royal Air Force (13 units and options for 7 more) has not materialized but the manufacturer's Scottish division has undertaken a considerable marketing effort bearing, in particular, upon a commuter variant capable of transporting 18 or 19 passengers and to cover three successive segments of 160 km each without refueling.

In January the decision actually to start up the series again was made and 10 airplanes put into production. B.Ae hopes to be able to justify later on an average production rate of about two units per month. To date "commitments" for 13 airplanes and options for 9 others have been executed by 5 airlines. To this should be added letters of intent for 30 to 40 airplanes coming from a total of 16 operators. The first mass produced "Jetstream" 31 will come off the line at the end of this year.

Shorts: The First on the Market

From the small "Skyvan" to another unpressurized airplane of greater capacity, the 330, Shorts has, through the years, succeeded in selling about 70 airplanes of this model to 20 users throughout the world. This production is no doubt insufficient to make the program profitable but, on the other hand, enough to assure the British company some entry into the market.

Short plunged into a quick program whose objective is to deliver a still unpressurized airplane with 36 seats, the model 360, at the end of 1982. Thus the company will be the only one on the market for a year or 2 until the SF-340, Dash 8, and "Brasilia" arrive.

Officially started in July 1980, the Shorts 360 is to fly for the first time next December and receive its certification in October 1982. Suburban Airlines in the United States will be the first airline to receive an airplane. Despite the advantage which this schedule gives it the 360 has not obtained many orders. At the end of last year only six airplanes could be counted: four for Suburban Airlines and two for Chautaugua.

The 360 is a twin turboprop (two Pratt and Whitney PT6A-65R of 1,294 horsepower), with high wings reinforced by spars. The fuselage has a square cross-section which allows easy arrangement of three abreast with an aisle.

The principal characteristics of the 360 are as follows: wing span of 22.76 meters (the same as the 330), length of 21.49 meters, and height of 7.19 meters. The cabin measures 1.93 meters in width, 1.93 meters in height, and 11.02 meters in length.

The maximum weight at take-off is 11,657 kg, the operational empty weight 7,480 kg, the maximum payload 3,184 kg, and the maximum weight of fuel carried 1,741 kg.

Pratt and Whitney have improved the specific consumption of the PT6A-65R by about 5 percent, which results in a range with maximum payload of 480 km. The maximum cruising speed is estimated at 391 km per hour.

Saab-Fairchild: A Trans-Atlantic Alliance

For a long time the Swedish Saab company sought to balance its military activities with a civil project. Several years ago it had started out with the idea of a small cargo airplane, the "Transporter," but nothing came of it. The growth of the commuter market at last gave it the opportunity it sought for an alliance with a major American manufacturer, Fairchild, already well positioned among the commuter airlines by virtue of its Swearingen subsidiary. This trans-Atlantic alliance was realization of the dreams of all European manufacturers tempted to develop a commuter airplane, the major portion of the market for the immediate present being in the United States.

With the "Metro" II, a fast pressurized twin turboprop with 20 seats, Swearingen occupies an enviable position in the commuter airplane market. The new airplane designated SF-340 should extend the success of this elegant machine.

The SF-340 is the direct competitor of the EMB-120 "Brasilia." The two airplanes have a large number of similarities even though the manufacturers have chosen different engines: the SF-340 has two general Electric CT-7-5 of 1,600 horsepower driving Dowty four-blade composite propellers. The two airplanes are derived from the same philosophy and are aimed at the same market. Saab and Fairchild have a rapid development program underway which should result in a first flight in the middle of 1983, certification at the end of 1983, and first deliveries in the middle of 1984. Taking into account the foreseeable delay of the "Brasilia" the SF-340 could be the only one on the market for about a year, an advantage which Saab and Fairchild expect to put to good use.

Production will be divided equally between Fairchild and Saab. All the airplanes will be assembled and flight checked by Saab at Linkoping. Fairchild Republic will construct the wings, the tail, and the engine nacelles. Saab will construct the fuselage.

Marketing in the United States, Canada and Mexico will be undertaken by Swearingen Aviation. The rest of the world is the province of a joint subsidiary of Saab-Scania and Fairchild, Saab-Fairchild HB, established for the purpose.

Quite recently a specific organization was established to manage the program with Alan R. Buley as director. The new organization has led to formation of a program management council comprising seven members: three from Fairchild and four from Saab-Scania.

Like Embraer, Saab-Scania has had to expand its manufacturing installations to achieve its production objectives. A plant with 6,000 square meters of enclosed area is under construction at Linkoping. The installation, which will cost 125 million Swedish crowns, will be completed in the summer of 1982.

The price of the SF-340 has not been officially announced, nor the orders and options already received; however it is believed that the cooperating companies intend to announce their early results during the Le Bourget Salon in June. About 70 orders are said to have been already obtained, divided practically equally between North America and Europe.

Intermediate Capacity

The SF-340, like the "Brasilia," is an airplane of conventional design: low wings (with single flaps), fuselage with three seats abreast and an aisle, and pressurized at 7 pounds per square inch (psi). On the other hand market studies have resulted in a capacity greater than that of the Brazilian aircraft. The SF-340 has 34 seats spaced at 30 inches (0.76 meter) in the standard configuration. It thus lies almost at the middle of the various capacities planned by the manufacturers of the new generation of commuter airplanes (30/31 seats for the EMB-120; 36 seats spaced at 31 inches for the DeHavilland Dash 8).

The principal characteristics of the SF-340 are as follows: length 19.67 meters, wingspan 21.44 meters, and height 6.87 meters. The cabin measures 10.57 meters long, 2.16 meters wide, and 1.83 meters high at the center; the floor is 1.70 meters wide. The standard configuration is 34 seats spaced 30 inches in 11 rows, 10 of 3 seats and 1 of 4 at the rear against the bulkhead which separates the baggage compartment which has a volume of 6.4 cubic meters, that is 0.2 cubic meters per passenger. A cloakroom and toilets are provided forward. It should be noted that the floor is not flat: the aisle is slightly lower in order to gain height below the ceiling.

The maximum weight at take-off is 11,340 kg, the same as the maximum landing weight. The empty weight in the standard configuration is 668 kg [?-as published] and the maximum weight without fuel is 9,980 kg. The commercial load is limited to 3,311 kg and the fuel capacity to 2,676 kg (the fuel is contained in four tanks, two in each wing).

With 34 passengers the SF-340 has a range of 1,520 km with IFR standard reserves. The range is increased to 3,035 km with only 22 passengers. The maximum cruising speed is 260 knots (480 km per hour) and the economical cruising speed is 211 knots (391 km per hour) at which speed the airplane consumes 27.67 kg of fuel per hour.

The take-off distance (FAR 25) with a weight of 11,340 kg at sea level under ISA conditions is 1,082 meters; it increases to 1,250 meters at ISA + 15°C. At an altitude of 5,000 feet (1,525 meters) these values increase to 1,402 meters and 1,707 meters respectively.

The engines merit special mentions. The SF-340 is the first airplane for which the General Electric CT 7-5 was chosen. This engine derived from the T-700 gas turbine, with which the Sikorsky "Black Hawk" and "Sea Hawk" are equipped, claims a lower specific consumption than that of the Pratt and Whitney PT7A; from his workbench the motor mechanic claims 0.45. It develops 1,600 horsepower without modification up to ISA + 15°C.

Embraer: An Unexpected Outsider

Ten years ago with some measure of condescension the aeronautical world contemplated Brazilian efforts to establish an aeronautics industry. Embraer had just been established and flew the first prototypes of the EMB-110 "Bandeirante," an unpressurized twin turboprop of somewhat squat shape, with semi-retractable landing gear and mediocre performance.

With improvement after improvement the "Bandeirante" has become a beautiful airplane whose elegance and performance compare favorably with those of other airplanes of the same class. Practically forced upon the Brazilian market by the government, the "Bandeirante" has proved itself there, which has enabled its manufacturer to invade the foreign markets. There, little by little, mistrust has given way to some confidence in the airplane, which has proved rugged and economical, and in the manufacturer, who is making a determined effort to add to its sales.

The "Bandeirante," of which there are now several versions, has made good penetration into the United States and also enjoys good sales in Europe (in France Air Littoral and Brit Air operate several units) and in Africa. In toto, 120 "Bandeirante" airplanes of all types have been delivered to the export market.

While the success of the "Bandeirante" was being affirmed, Embraer began studying and developing a new family of pressurized twin turboprops of more modern design. Thus the EMB-121 "Xingu" was born from which two airplanes of much greater capacity were to be derived. The evolution of the market has resulted in revision of this plan without, however, deviating from the original idea which consisted of ultimately having available a complete range of airplanes with capacity between 5 and 30 passengers. At the end of 1979 and the beginning of 1980 it was thus decided to start on a new airplane, the EMB-120 "Brasilia" and a pressurized version of the "Bandeirante," the EMB-110-P3.

Despite amazing growth--Embraer today employs nearly 5,000--the Brazilian company has trouble in coping with the ensemble of programs it has been induced to start. In fact, it is developing a military training airplane, the EMB-312, participating in the Italian-Brazilian AMX attack aircraft program, and building a new elongated version of the "Xingu," along with the expansion of its commuter series. This situation has resulted in putting the development of the EMB-110-P3 temporarily on hold and it is already obvious that the "Brasilia" project's original plans will suffer a delay now estimated at about 1 year. The first deliveries may therefore come about only in the beginning of 1985.

However that may be, the "Brasilia" is benefiting from the market position attained by the "Bandeirante." Already nearly 100 options have been taken by various airlines, for the most part already Embraer customers.

With the "Brasilia" Embraer contemplates a mixed civil and military market. The company's preliminary studies led it to envision 65 percent of its airplane sales to commuter airlines, 32 percent to the military market, and 12 percent to various private markets (corporate business airplanes) and quasi-public markets (VIP, calibration, geographic surveys, etc). The main portion of the market for the "Brasilia" is obviously seen on the South American continent (32 percent) taking into account, in particular, orders from the Brazilian armed forces. There is talk of 20 maritime patrol and electronic countermeasures aircraft. The next largest market is in North America (25 percent). Europe should take 17 percent of the "Brasilia" production, Australia and the Pacific region 10 percent.

Embraer estimates that between 1984 and 1990 there will be demand for 450 to 600 airplanes of the EMB-120 class, that is, in the 30-seat category. The company believes it will capture 40 percent of this market and thus sell 160 to 190 airplanes, which leads it to contemplate a production rate varying from two to three airplanes per month.

Conventional design: The EMB-120 is a pressurized (7 psi) twin turboprop with low wings and T-shaped tail fitted with two Pratt and Whitney 1,500-horsepower PT7A-1 driving four-bladed Hamilton Standard propellers of 3.20-meters diameter at 1,300 rpm.

As with all new airplanes the characteristics and performance are subject to change. Since the first showing at Rio de Janeiro on 25 April of last year, several important alterations have already been made to the initial project.

Thus, the fuselage has been widened by 7.6 cm to clear a flat cabin floor for facilitating conversion to cargo, and the baggage compartment capacity has been increased to 6.5 cubic meters (0.2 cubic meter per passenger) and to 600 kg.

The exterior dimensions of the "Brasilia" are as follows: length 19.77 meters, wingspan 19.625 meters, and height 6.05 meters. The fuselage has an outside diameter of 2.27 meters, the cabin measures 18.38 meters long, 2.15 meters wide, and provides maximum height below the ceiling of 1.75 meters. It is normally arranged with 30 seats spaced 31 inches (0.79 meter).

The maximum weight at take-off is 9,072 kg, the maximum weight on landing 8,872 kg. The empty weight in standard configuration is 4,950 kg and maximum weight without fuel 8,400 kg. The maximum commercial load is 3,130 kg. The total fuel capacity is 3,220 liters.

With full passenger load the "Brasilia" has a range of 650 km, taking standard reserves (100 nautical miles, 45 minutes) into account. With full fuel load and commercial load of 1,300 kg the range goes to 2,700 km. The maximum cruising speed is on the order of 540 km per hour.

The take-off distance with maximum weight at sea level under ISA conditions is on the order of 1,100 meters.

The PT7A-1 turbines generate 1,500 horsepower up to ISA + 22°C. It is to be noted that by means of a brake upon the starboard propeller the engine can be used on the ground as an APU [airborne auxiliary power unit].

De Havilland Canada; A Specialist

De Havilland Canada is the one manufacturer which, along with Beechcraft mainly, has made possible the blossoming of the commuter phenomenon. Many airlines owe their success to the "Twin Otter," a rugged, short take-off airplane adapted to operations under all climatic conditions, at all altitudes. Today the Canadian company has perfected a program policy which should enable it to make the most of the favorable position it has attained during the last 15 years (AVIATION MAGAZINE INTERNATIONAL No 793 p 25).

For De Havilland, the commuter aircraft market is a matter of range. In contrast with its main competitors, who depend only upon one or two airplanes, most often an airplane of a former generation, to which they are attempting to add a new airplane of greater capacity, the Canadian company intends to offer a complete series of airplanes from 19 to 50 places, and even beyond that.

At present in production are the "Twin Otter," of which nearly 800 units have been sold, and the Dash 7, a four-engine turboprop with 50 seats, 120 units of which have been ordered. To close the gap between these two airplanes De Havilland has started on an airplane with 36 seats (spaced at 31 inches), the Dash 8, whose first flight is planned for 1983.

The physical characteristics of the Dash 8, a twin turboprop with high wings, were recently confirmed: wingspan 25.60 meters, length 22.25 meters, and height 1.88 meters; following are the cabin dimensions: length 9.75 meters, floor width 2.03 meters, maximum width 2.49 meters, and maximum height 1.88 meters. In contrast with the majority of competitors the standard arrangement has four seats abreast with a central aisle, which makes it possible to contemplate an elongated version later on. But such a development presumes a parallel evolution to increased capacity of the Dash 7 in order to retain the spread of the series. Thus, between now and the end of the decade we may expect to see a Dash 7 lengthened to about 70 to 75 seats.

The Dash 8 has a range of 570 nautical miles (1,056 km) with full passenger load and standard IFR reserves.

Like the "Brasilia" the Dash 8 will be equipped with two Pratt and Whitney PT7A turbines but in the -2R version which develops 1,800 horsepower (the maximum take-off weight of the Dash 8 is 13,834 kg). The engines drive four-bladed Hamilton Standard propellers at 1,200 rpm for reduced noise.

De Havilland's market study is undoubtedly the most realistic of those which have been made because it is based upon great practical knowledge of the field. Between now and 1995 the company expects to sell from 600 to 650 airplanes out of a total market estimated at 1,800 airplanes, including orders from commuter airlines, military organizations, and companies which have need for large business airplanes (corporate market).

In fact, the Dash 8--which is not an ADAC in contrast with the "Twin Otter" and Dash 7--has the greatest chances for success and De Havilland is well situated for retaining its supremacy in the commuter aircraft market which it regards as somewhat its own.

CASA/Nurtanio: Grasp the Opportunity

The Spanish company, CASA, in order to widen the market for its small "Aviocar" cargo plane, developed transport versions of it capable of seating 19 to 25 passengers, depending upon the version. This aircraft is now being operated by several airlines, notably in the United States by Allegheny Commuter in Ohio. The experience should now be put to good use in developing an entirely new airplane in cooperation with the Indonesian company, Nurtanio, which is already participating in manufacture of the CASA 212 "Aviocar."

Involved is a pressurized twin turboprop with high wings (which has a distant family resemblance to the Nord 262) equipped with two General Electric CT 7-5 engines of 1,700 horsepower. The airplane is designated CN-235.

The specifications for the airplane are not completely fixed but for the present there is talk of a capacity of 35 places and of a cargo version. The maximum take-off is said to be 13,500 kg and 13,200 kg on landing. An increase later on of the maximum take-off weight on the order of 20 percent is planned.

Started by the two cooperating companies with their own funds, the CN-235 has the benefit of no official financial support. It is defined as a multipurpose airplane, that is, it is aimed at the military market as well as the commuter market.

The first flight is now planned for September 1983, which indicates the start of deliveries at the end of 1984 or beginning of 1985.

Aerospatiale/Aeritalia: Uncertain at the Start

The "aircraft" division of Aerospatiale [National Aerospace Manufacturing Company] in search of programs capable of conserving its capabilities as an aircraft manufacturer, about 2 years ago launched the concept of a regional transport aircraft. Its ultimate aim, less of taking the place of the Fokker 27 than of taking a share of the market at which the new generation of 30-35 places was aiming. (AVIATION MAGAZINE INTERNATIONAL No 790 pp 50-51). Aeritalia for its part was orienting toward a program with similar characteristics, the AIT-230. The two companies therefore decided to cooperate in the definition of the future aircraft whose present designation is ATR-42. Recently the agreement between the two companies was renewed until the summer in order to continue studying the definition.

Aerospatiale has some experience with commuter airlines by virtue of the Nord 262, but invasion of the American market requires a starting base there. From this arose various negotiations with American manufacturers, notably Piper, and also study of connections bearing upon the direct installation of a manufacturer like the one set up to invade the American civil helicopters market.

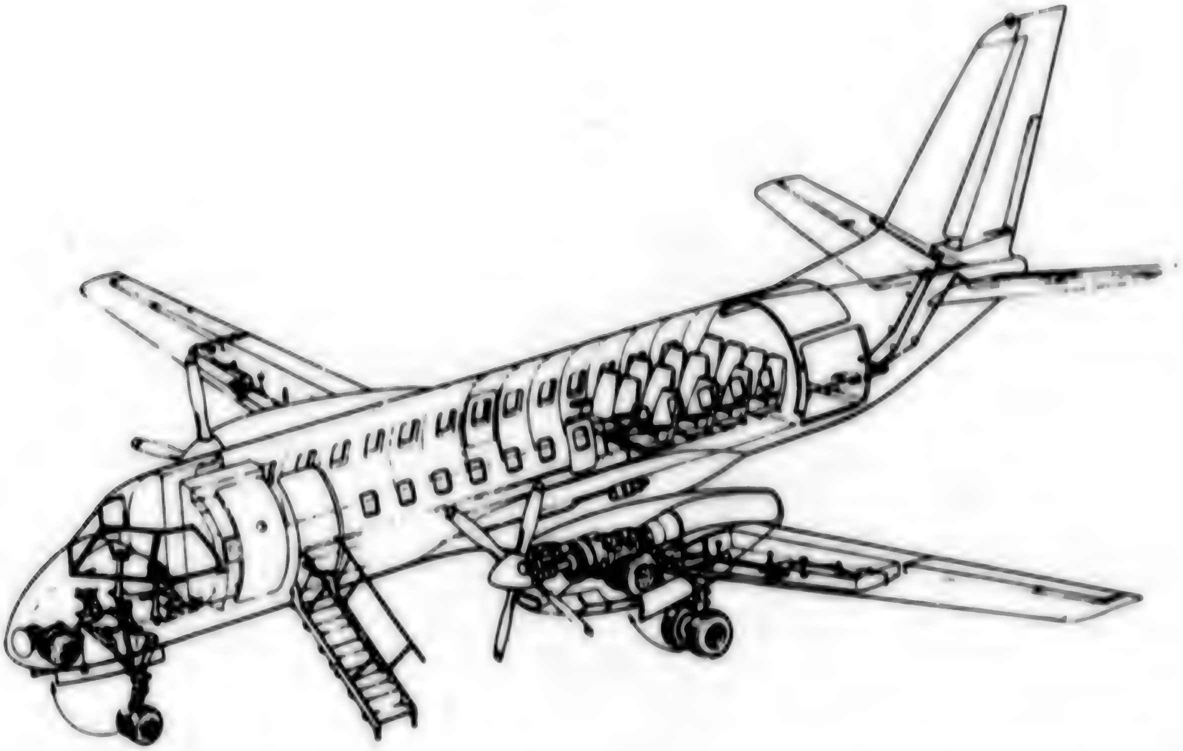
The ATR-42 (alias AS-35) is planned in three versions: standard, elongated, and cargo, corresponding to the three markets contemplated: commuter airlines in the strict sense, regional airlines, and military markets. The basic version is to be arranged with 42 seats spaced at 32 inches (or 46 spaced at 30 inches). The elongated version, whose development depends upon market evolution, will have 54 seats spaced at 32 inches (or 58 spaced at 30 inches). The fuselage cross-section allows installation of four seats abreast with a central aisle.

The ATR-42 is a conventional airplane, twin turboprop with high wing and T-shaped tail, a formula reminiscent of that of the Dash 8, but the airplane is considerably larger since it is aimed at competing with the Dash 8 and present Dash 7 at the same time.

Aerospatiale has conducted its market study in remarkable fashion and its conclusions can be questioned only with difficulty. However, despite the 770 to 1,100 airplanes which the company estimates can be sold between now and the year 2000 the start-up of the ATR-42 is not certain. It requires, in fact, the support of the French Government which up to now has not agreed to do so. Among the reasons for which the project may be aborted the most frequently cited is the impossibility of financing and constructing an expansion of the Airbus line (the A-320 project) and the ATR-42 at the same time. In addition, there remains doubt, shared by the other manufacturers of commuter aircraft, as to the solvency of the airlines which constitute the market.

Thus it will not be known whether Aerospatiale and Aeritalia will actually start in the race to the new commuter airplanes until the middle of the year.

The latest development in a family which began with the small "Skyvan," the Shorts 360 will be the first upon the market, an important trump card if traffic grows rapidly but which will not be enough to open up to it a share of the market for fast, pressurized airplanes....



With low wings, pressurized fuselage, and seats arranged three abreast with an aisle, the Saab-Fairchild 340 is typical of one of the three large trends among manufacturers of commuter airplanes. The other two are characterized, respectively, by a pressurized fuselage with seats four abreast and high wings (ATR-42 and Dash 8) and by an unpressurized fuselage with square cross-section and, also, high wings (Shorts 360 and CASA 212).

After an exceedingly slow start the De Havilland Dash 7 has now started out upon a promising career. It has benefited from the rapid growth of regional transport and absence of real competition in its market segment, that of short take-off 50 seaters....

The CASA 212 series 200 has successfully started to penetrate the commuter airplane market which has undoubtedly whetted the appetite of the Spanish manufacturer, now cooperating with the Nurtanio company.

This is a wind tunnel mock-up of Aerospatiale's ATR-42, alias AS-35: a conventional design but construction of which should exploit all the technological resources of the French manufacturer, which is working in cooperation with Aeritalia.

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TRANSPORTATION

LPG GAINS IN POPULARITY AS ALTERNATE FUEL

Munich SUEDDEUTSCHE ZEITUNG in German 27 Mar 81 p 27

[Article by Eberhard Seifert: "Interest Developing in Liquefied Petroleum Gas [LPG]. 7,000 Cars Using Liquefied Natural Gas. DM750 Can Be Saved With 30,000 km Use Per Year"]

[Text] Just as the Americans nationally favor the electric car, since in the future it can also be considered for so-called "fleet use" of all models of one make, the Federal Government is planning to tax LPG at a lower rate; at present it costs about 30 pfennigs less per liter than premium gasoline. Provided that a suitable network of filling stations is developed this could mean more active use of this fuel.

LPG is a comprehensive term. Basically what it means is hydrocarbons which occur naturally or accumulate as synthetic gas. The most important raw materials for LPG producers are natural gas, petroleum and coal. LPG's are obtained in refineries from the distillation of petroleum. Natural gas, however, also accumulates when pumping petroleum and for technical reasons has up to now been burned off as useless--a waste of energy which for some time we have no longer been able to afford. The gases can be liquefied at room temperature under slight pressure and in the process are reduced to about one-six-hundredth of their volume: of course, they can be reconverted to the original gaseous state at any time.

At the moment a large interconnected system is being developed. Algeria has enormous natural gas deposits. Starting in 1983 liquefied natural gas from Arzev is to begin arriving in Europe at an annual rate of 10 billion cubic meters, half to be used in Holland and half in the FRG. Since it is based on crude oil, natural gas can, of course, replace neither gasoline nor diesel fuel, but it can stretch them! Nonetheless, it is a definite alternative to petroleum since the problem of liquefaction and reevaporation has been solved.

Share of Imported Gas: 62 Percent

In the FRG in 1979, 1.5 million barrels of LPG were consumed for energy purposes. Converting an automobile to operate in addition on fuel gas is not at all so costly. The following are necessary to do this:

--In the luggage compartment there is a special tank which holds from 60 to 120 liters, which by necessity does reduce storage space for baggage. It must with-stand a pressure of 30 bars, have an excess pressure valve and for safety reasons may be filled only 80 percent.

--In addition, about 4 meters of copper coil and also magnetic shut-off valves are required to operate on gas or gasoline, because while driving it is possible to switch, as desired, at the dashboard to whatever fuel is available.

--In an evaporator which is heated by cooling water or exhaust gases the liquid fuel is converted back to gas and reduced to the necessary pressure.

--Finally, in a mixing device installed between the air filter and carburetor the gas is provided with air for combustion and fed to the engine.

--A complete installation of this gas system with a 6-month guarantee costs DM1,635 for the Audi 80, DM1,840 for the BMW 520 and DM1,765 for the Mercedes 280 SE. In addition, there are the value-added tax and the costs for the TUeV [FRG automobile inspection] approval.

Interest is developing in LPG because it is not affected by the planned increase in the tax on petroleum. At present 1 liter of this gas costs 93 pfennings; of this amount, according to information from the LPG association, 32.16 pfennigs represent tax. One liter of gasoline, moreover, is the equivalent of 0.5242 kg of LPG at 6°C. Since the gas has an octane number of about 100 ROZ [research octane number], no lead additive is needed as an antiknock agent. Thus, LPG has a relatively high calorific value. Combustion is gentle and practically free of residues. Clean spark plugs and larger oil change intervals without diluting the lubricating oil, even in short-distance traffic, bring about a genuine decrease in wear and tear--the engines last longer. Even the pollutants in the exhaust are free of lead and sulfur: LPG is definitely compatible with the environment.

The additional consumption that is about 10 percent higher than in a comparable gasoline engine is a drawback which, because of the lower energy density, is associated with a roughly equivalent decrease in output and a somewhat poorer cylinder charge. This is most noticeable when accelerating. It is understandable that the heavy pressure container with the somewhat awkward filling method also has a negative influence on the weight per horsepower. The greatest handicap, however, is the supply network which has not yet been satisfactorily solved; so far there are still too few LPG filling stations. At present, in congested areas in the FRG there are ostensibly about 150, as compared to around 27,300 regular gas stations. For reasons of safety they must, of course, be located 35 meters from moving traffic.

The radius of action which is increased by double tank capacity (gasoline and gas) is a real plus. The English make Bristol in 1979 equipped its cars in series production with two LPG containers in addition to the gasoline tank so that they were in a position to proudly announce an action radius of 750 to 800 km. The Lancia-Beta has been in existence in Italy for many years with an LPG engine, while the Volvo 244 GL has been available from the factory since 1979 with an engine for two-fuel operation. Moreover, in Japan almost all taxis run on fuel gas. Citroen is working on a "Dyane," which operates on LPG, that is, on a propane-butane gas mixture; it is to be introduced as the "Acadyane." In France about 20,000 cars were converted to fuel gas operation in 1979; increased use is anticipated by taxis.

Gas as a fuel is not new. In 1860 Lenoir experimented with his famous engine which worked on an air-gas mixture (95 percent air and 5 percent illuminating gas). Even Nikolaus August Otto, who was the first as a partner of Langen in Cologne-Deutz to produce gas engines, occupied himself with it. The same is true of Gottlieb Daimler, Benz and Maybach--until the demand for more efficient drive units caused gasoline to replace gas. Carburetor engines are definitely suited to LPG operation, injection engines are out of the question because of problems with gaskets and diaphragms in the fuel system; in the case of diesel engines experiments are in progress with a special diesel-gas mixture.

If in the future automobile gas is considerably cheaper than the liter price of premium gasoline, then, according to gasoline and petroleum calculations, DM750 can be saved annually with 30,000 km of use per year as compared to conventional gasoline; the conversion could perhaps be amortized in 2 years. Moreover, nothing is changed in respect to the liability classification, only with full comprehensive insurance does the rebuilding cause added value so that the additional charge is met. According to official statistics, there are at present in the FRG about 7,000 automobiles which can be operated on gasoline or LPG, as desired.

In Holland every fifth car uses LPG, especially since it is sold there without a petroleum tax and is thus only half as expensive as in Germany. The bottom line was and is an efficient supply system with numerous filling stations. If that is realized, then in view of the price policy of the petroleum conglomerates, LPG could make a contribution in the energy sector to detente.

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BRIEFS

FLAWS IN ADVANCED PASSENGER TRAIN--England's express train of the future, British Rail's "Advanced Passenger Train" (APT) has dangerous flaws. The APT has a special automatic tilting mechanism which is supposed to allow it to take curves 40 percent faster than traditional trains and, for example, should save 1 hour of travel time on the very curvy London-Glasgow route. The automatic device gives the tops of the cars an additional 9-percent tilt toward the inside of the curve beyond the existing incline of the wheel frame in banked curves. In trial runs with three test trains the return mechanism failed to work now and then, the 9-degree tilt of the cars remained even on straight routes or in curves going in the opposite direction. If an APT were thus tilted toward the wrong side and if it were to meet, in a narrow curve, a train of the same type of construction which is projecting to the correct side, the space between the tracks would no longer be adequate and according to the British science journal NEW SCIENTIST a "spectacular collision" would be "unavoidable." The experimental APTs are now being rebuilt. The APTs which will be available in 1984 at the earliest will not even achieve the desired maximum speed of 240 km/h. They will perhaps go 200 km/h. [Text] [Hamburg DER SPIEGEL in German 6 Apr 81 p 28] 12124

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